Analysing future energy system pathways of East, Central and West China in a global context

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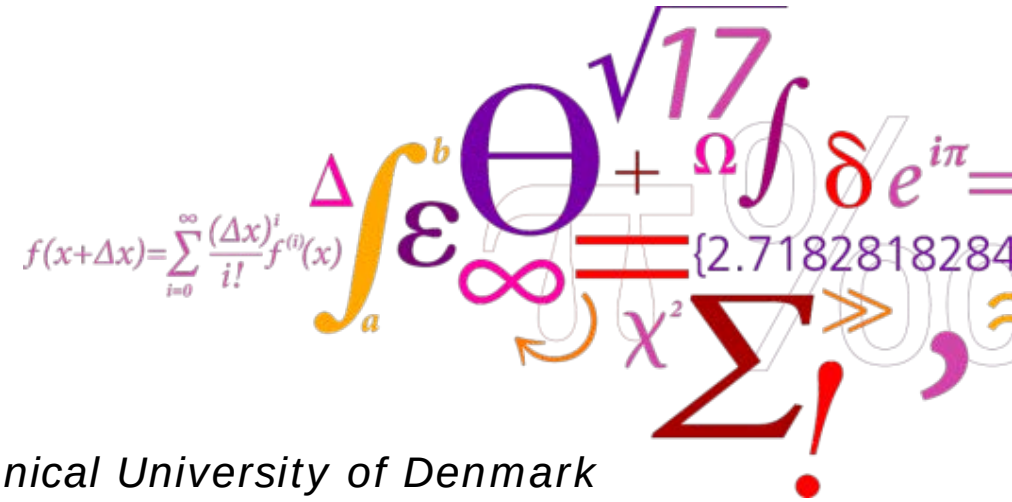

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Section I:

Personal introduction

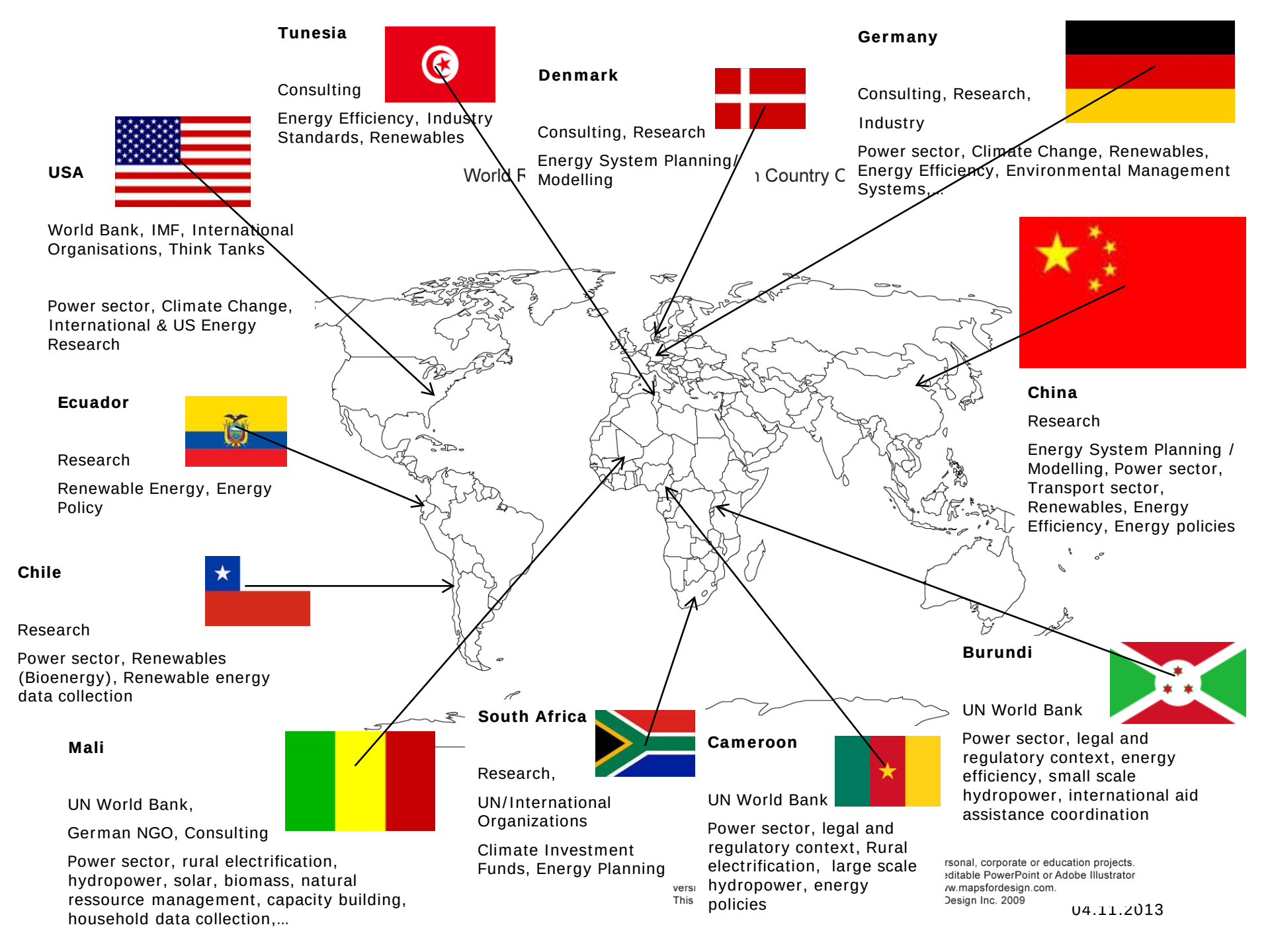
Education & work experience

Education:

- Master's degree in **engineering** with a focus on energy and environmental technologies; PHD in energy planning/modelling ongoing
- **Interdisciplinary** Forcus: economics, environmental law, environemental management systems for industry,…
- Working **languages**: German, English, French, Spanish, Danish,…

Work experience:

- More than 8 years in **infrastructure** and economic development, with a strong focus on the energy sector
- **Energy Sector Expertise**: renewable energy & energy efficiency technologies, project development & implementation, carbon finance and clean development mechanism, emerging markets finance, utility management, rural electrification, international energy research, technology transfer, energy policy design and evaluation, capacity building & training,…
- **Key employers**: World Bank, Africa Energy Group; Fraunhofer Research Institute UMSICHT; Airbus aviation; German energy utilities, German Technical Cooperation GIZ, various consulting companies,…



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Section II:

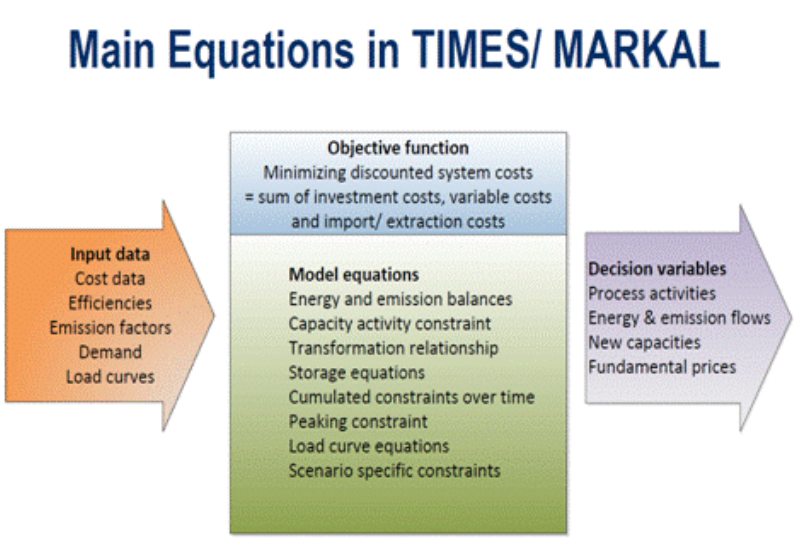
IEA ETSAP TIAM model background

IEA – ETSAP - TIAM

- The **International Energy Agency (IEA)**, an autonomous agency established in 1974, has the mandate to promote energy security through collective response to physical disruptions in oil supply and to advise on sound energy policy.

- The **Energy Technology System Analysis Program (ETSAP)** is one Implementing Agreements (IAs) of the IEA that supports energy system model development worldwide. More information: www.iea-etsap.org

- The **Times Integrated Assessment Model (TIAM)** is one energy system model under IEA ETSAP. Its main features are described in the paper "ETSAP-TIAM: the TIMES integrated assessment", model Part I: Model structure, by Richard Loulou and Maryse Labriet, Published online: 24 February 2007, © Springer-Verlag 2007.

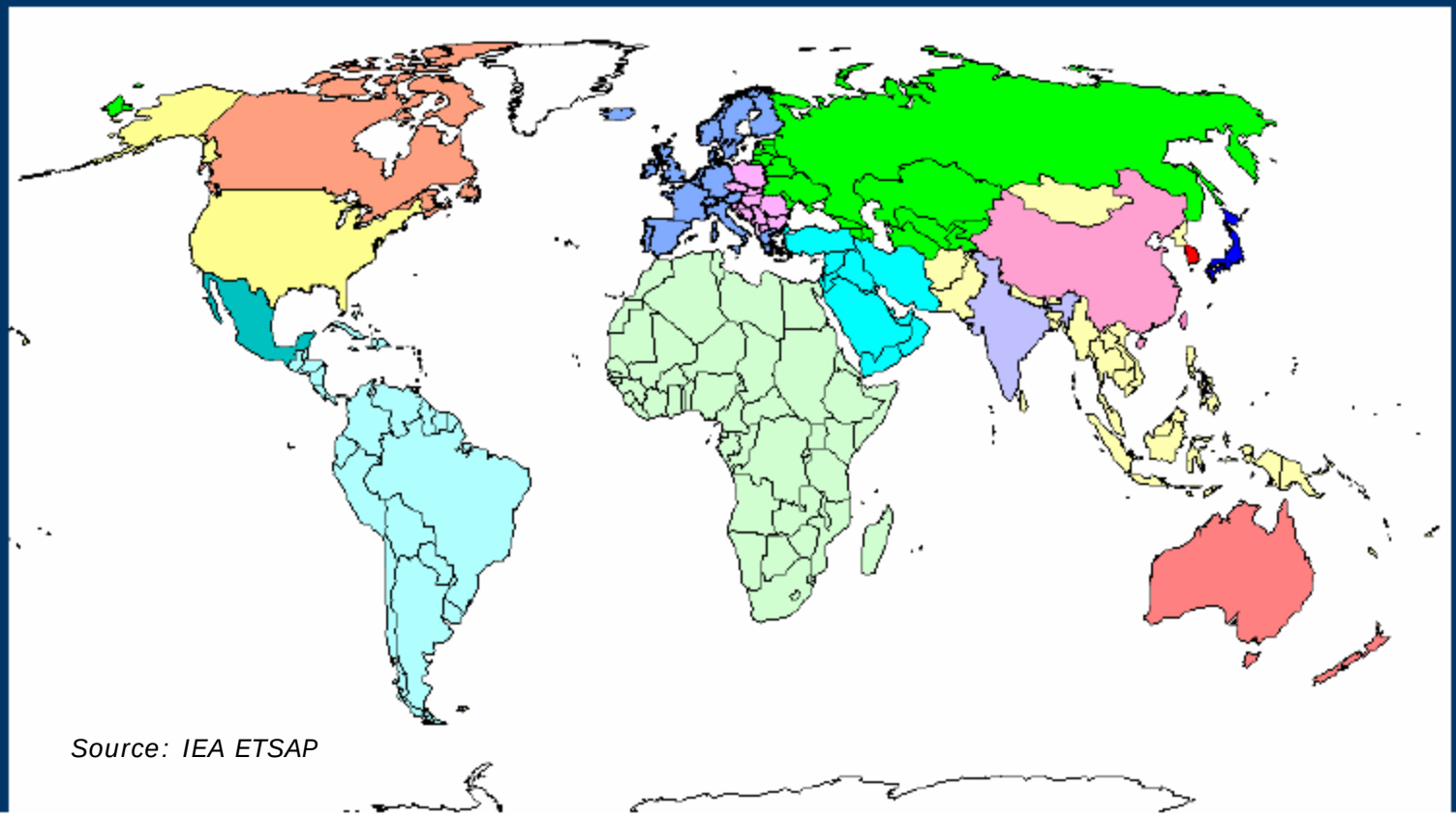


Topic	A typical Reference Scenario in TIAM
Geographical coverage	World divided in 15 regions
Time horizon	2005-2105
GDP, POP	Exogenous – from GLOBAL CGE models
Initial year	2005, based on the IEA Energy Balances
Supply side	Annual or cumulative amounts of fossil and renewable resources, representing the available resources and techno-economic limits to their extraction
Power plants	Annual or cumulative amount of renewable resources Range of nuclear generation
End-use sectors	No long-term market shares Industry: Both energy and feedstocks are included
Energy markets	Socially optimal: no regional production quotas apart from the technico-economic limits of extraction
Energy and climate policies	Not included

15 regions + OPEC/Non-OPEC

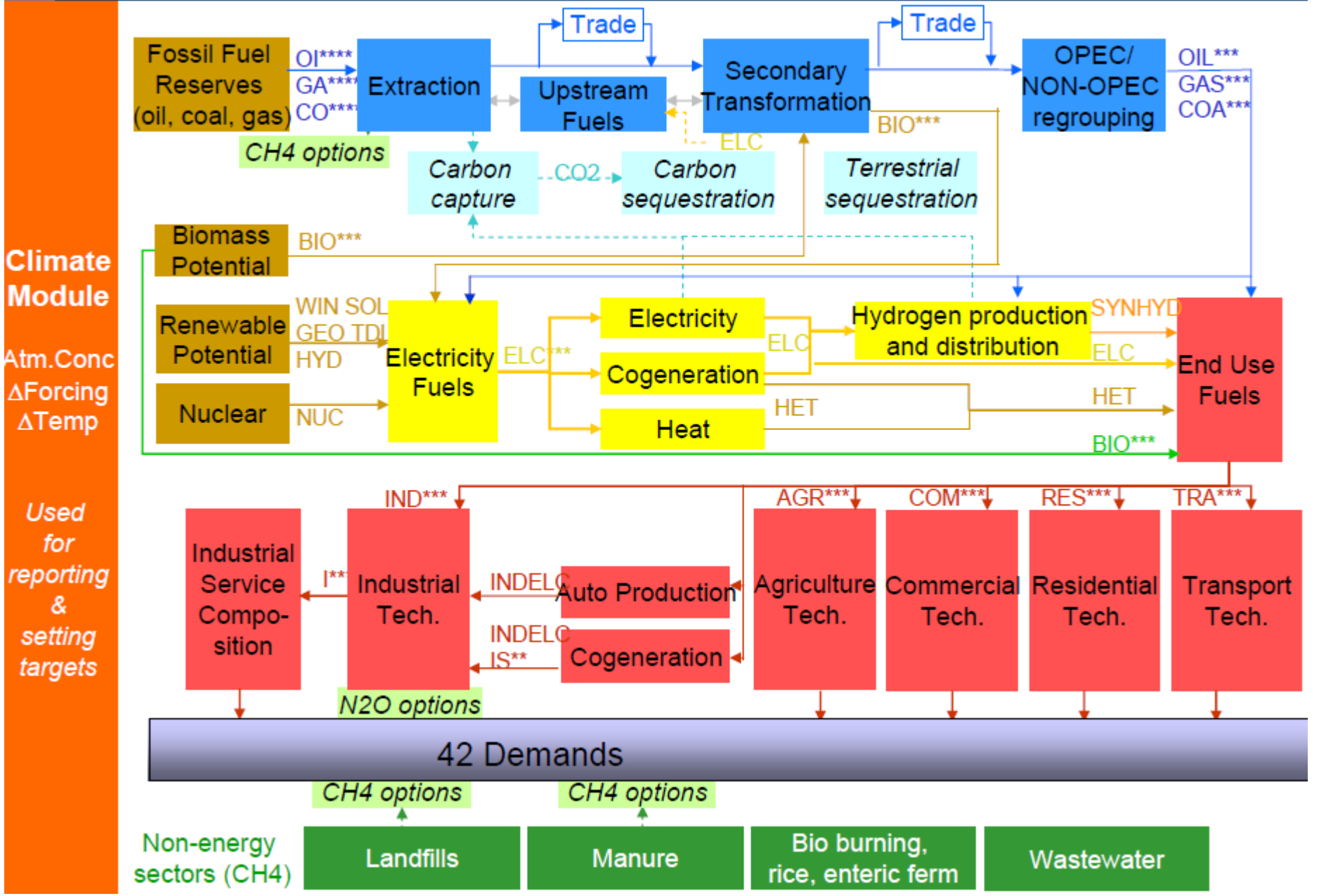
Africa*
Australia-New Zealand
Canada
Central and South America*
China
Eastern Europe
Former Soviet Union
India
Japan
Mexico
Middle-East*
Other Developing Asia*
South Korea
United States
Western Europe

* *OPEC and Non-OPEC countries are separated in primary and secondary sectors ⇒ oil production strategies and oil price control by OPEC countries*



Source: IEA ETSAP

Reference Energy System



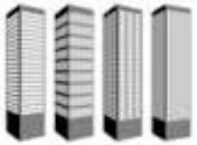
Source: IEA ETSAP

TIAM energy service demands – Multiple options for energy policy analysis

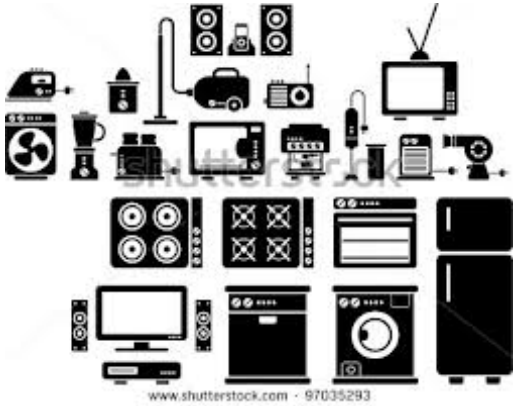
Industrial Energy-Service Demand
Iron and Steel Industry
Chemical Industry
Pulp and Paper Industry
Non-ferrous metals Industry
Non Metal Mineral Industry
Other Industries
Industrial and Other Non Energy Uses
Other non-specified consumption

Transport Energy-Service Demand
Domestic Aviation
International Aviation
Road - Bus
Road - Commercial Trucks
Road - Three Wheel Vehicles
Road - Heavy Trucks
Road - Light Vehicle
Road - Medium Size Trucks
Road - Auto
Road - Two Wheel Vehicles
Rail – Freight transport
Rail – Passengers transport
Domestic Navigation
International Navigation

Agriculture Energy-Service Demand
Generic agriculture demand



Commercial Energy-Service Demand
Commercial Cooling
Commercial Cooking
Commercial Space Heat
Commercial Hot Water
Commercial Lighting
Commercial Office Equipment
Commercial Refrigeration



Residential Energy-Service Demand
Residential Cooling
Residential Clothes Drying
Residential Clothes Washing
Residential Dishwashing
Residential Other Electric
Residential Space Heat
Residential Hot Water
Residential Cooking
Residential Lighting
Residential Refrigeration
Residential Others

Source for pictograms:www.shutterstock.com

Section III:

PHD project progress

Global and regional energy system modelling with focus on China

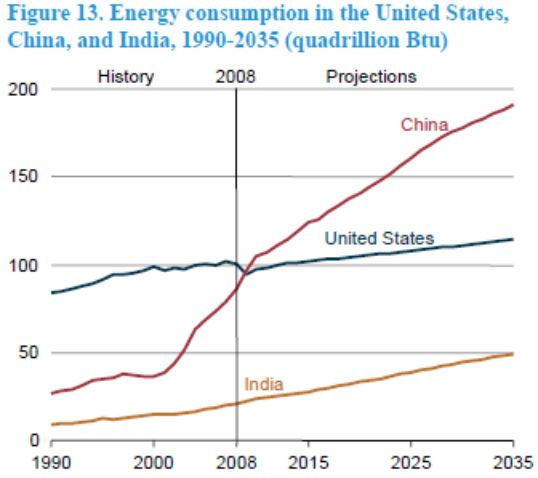
2012 - 2015

Added value of my research: An improved modeling of China´s regional energy characteristics in a global context

- China is at the centre of an unprecedented shift in the global economy and the global energy industry. Over the past decades China has experienced fast economic growth, accompanied by rapid urbanization, increasing energy consumption, widening regional disparities and soaring green house gas emissions.

- This remarkable growth has led to twin challenges for China: (i) improving environmental sustainability and regional economic development and (ii) enhancing energy security.

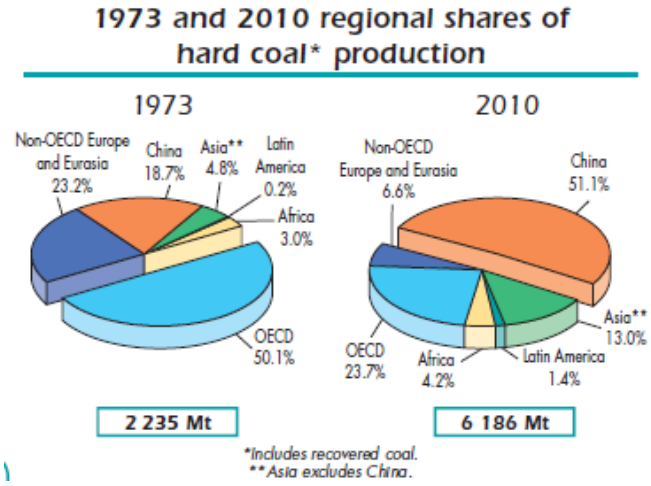
- Any major effort to minimize, mitigate and adapt to the adverse effects of climate change will need to better understand and integrate China´s future energy system pathways and related policy targets.



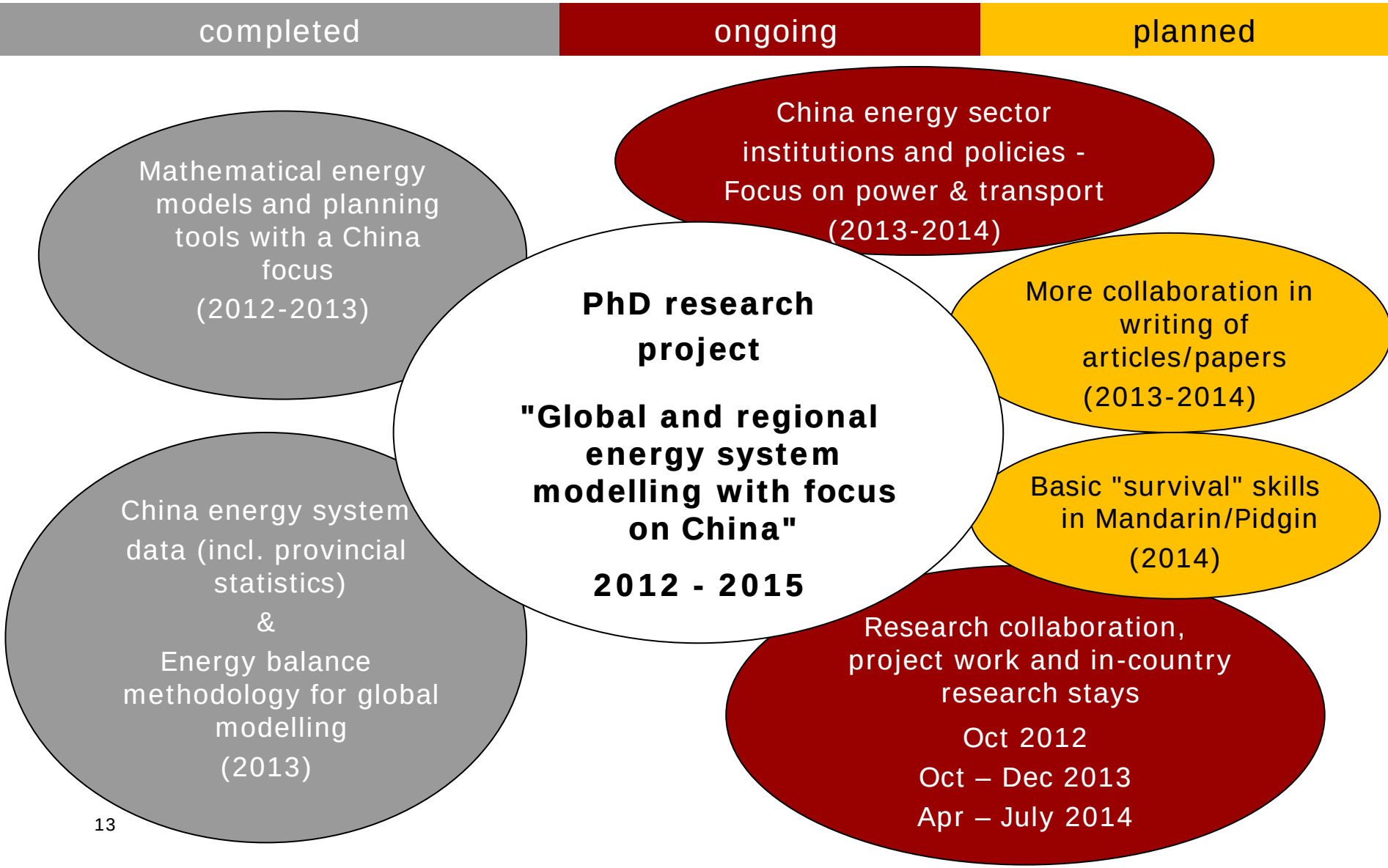
Sources:

Figure 13 from US EIA global outlook 2011 – China is the top energy consuming country

Regional shares of hard coal production, global from IEA Key World Energy statistics 2011 – China is the top hard coal producing country in 2010



PHD research project overview and timeline



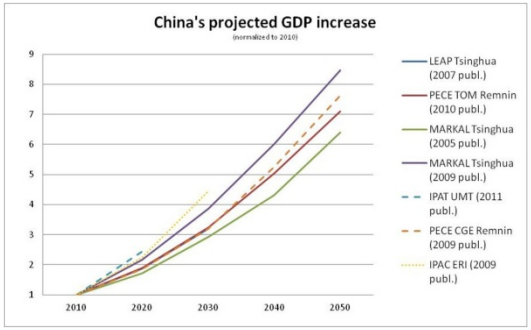
The models and tools from a Chinese perspective: A comparison of modeling results for China´s future energy system development

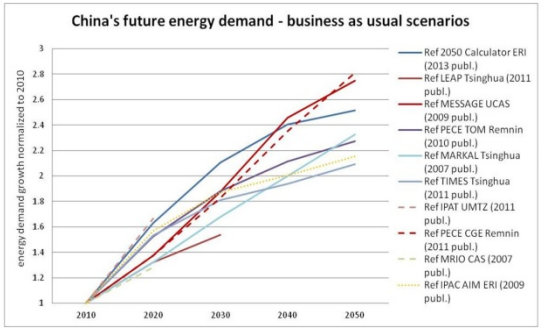
- Research area and methodology:

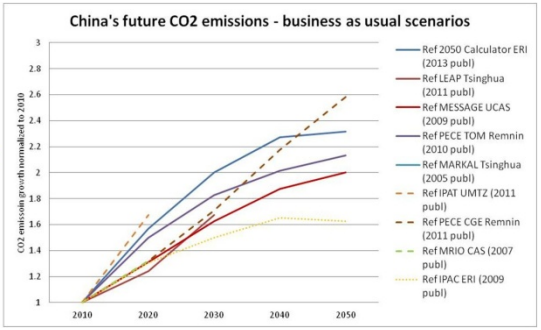
  The modelling structure, application areas, results and conclusions from more than 15 different mathematical modelling tools developed by various Chinese institutions were reviewed and compared to evaluate China's future energy system development from a Chinese perspective.

  A growing number of Chinese modelling tools is accessible in English language in academic journals and research reports since 2005, among them many bottom up and top down models.

- Research results indicate the following:
  - Key application areas: economic impacts of energy and climate policies (including GDP loss);
    the identification of optimal technologies for China's future power system
  - Key policy recommendations: a gradual and long term transition of China's energy system towards clean energy sources; likely CO2 emission stabilization period after 2030
  - Key technologies: mainly energy efficiency improvements, CCS deployment and increased nuclear power generation.







- *Source: Mischke, Peggy and Karlsson, Kenneth B. (2013): Modelling tools to evaluate China's future energy system - a review of the Chinese perspective. ENERGY* (Under Review).

The data challenge:
How to deal with energy statistics "full of Chinese characteristics" in an international context?

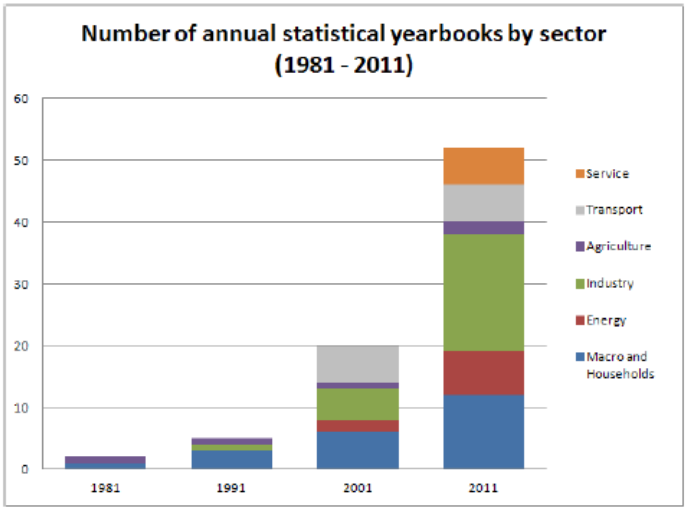


Figure 1: Increase of national statistical yearbooks in China (1981-2011)

Development of a simplified methodology to integrate selected indicators from Chinese national statistics in TIAM to distinguish energy systems for East, Central and West China – based on the IEA energy balance methodology (as used for other regions in TIAM)

Source:

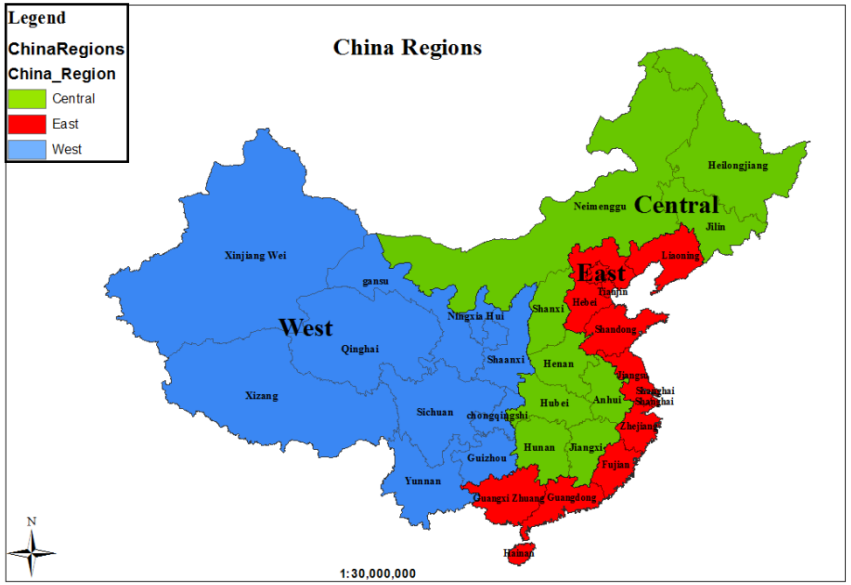
Mischke, Peggy (2013): China's energy statistics in a global context: A methodology to develop regional energy balances for East, Central and West China. MPRA DTU Working Paper 50145; published on October 1, 2013; 44 pages; http://mpra.ub.uni-muenchen.de/id/eprint/50305

The proposed regional representation of China's energy system in TIAM – Defining EAST, CENTRAL and WEST China

- The suggested sub-regional definition of China in TIAM is based on the PRC's Seventh Five-Year Plan (1986–1990), which grouped all provincial level divisions of China into three economic zones in order to promote medium to long term economic specialization and division of labour.

  → **18 Region global model version of TIAM**, based on 15 Region global TIAM 2011 version

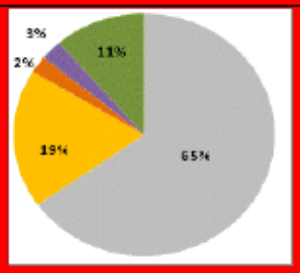
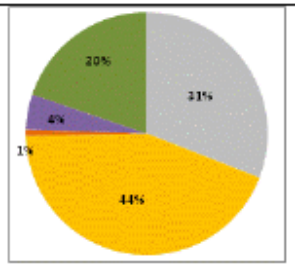
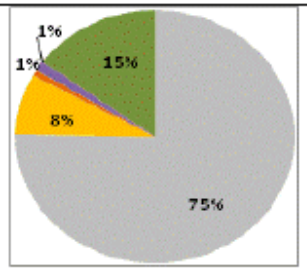
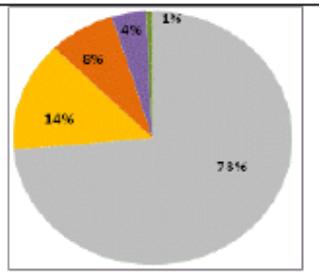
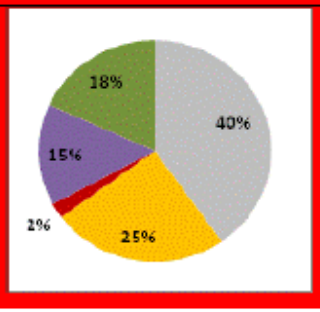
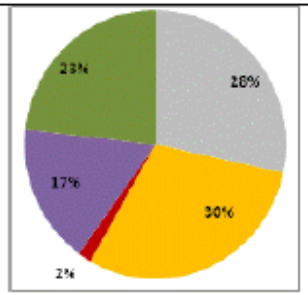
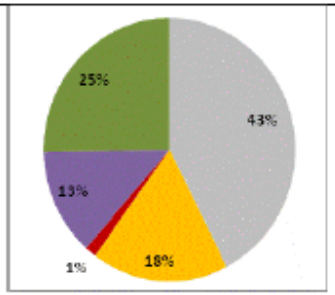
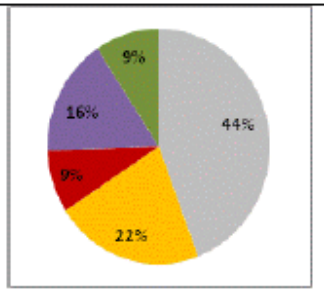
- **China East Region:** export-oriented industries, including steel, chemicals, engineering and textiles; in 2010 about 578 million inhabitants (44% of Chinese population) lived on 13% of China's land area; currently the economic powerhouse, accounting for more than 92% of China's exports and about 97% of China's GDP in 2010
- **China Central Region:** most of China's coal and metallurgical industries, as well as agricultural production; in 2010 about 440 million inhabitants (34% of Chinese population) lived on 29% of China's land area; crucial for supplying energy to the provinces in China's East Region.
- **China West Region:** the least developed region; marginal share of about 1% in China's GDP in 2010; in 2010 about 293 million inhabitants (22% of Chinese population) lived on 57% of China's land area; major hydropower resources



Sources:

PRC NBS Statistical Yearbook 2011; Economist 2012

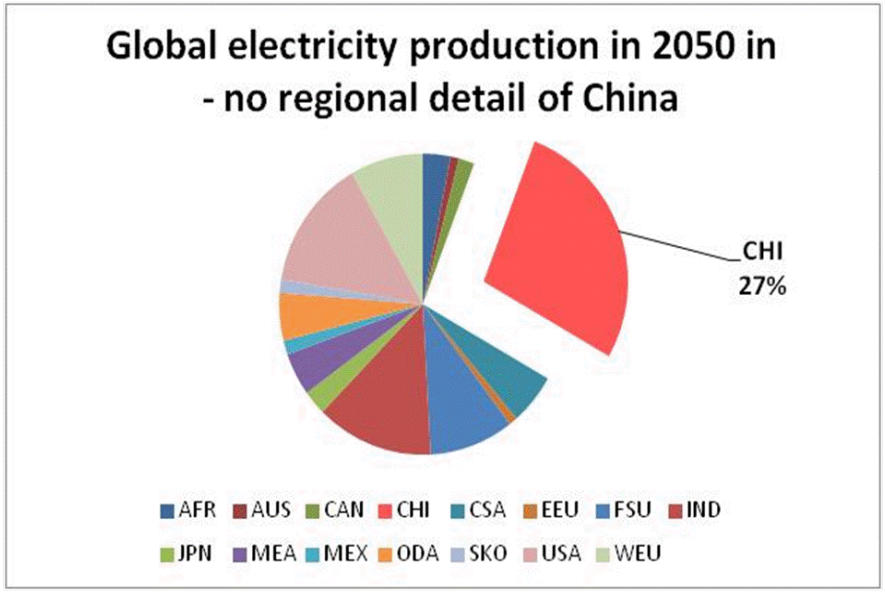
The new China energy balance methodology in TIAM – Fuel mix for primary supply and final consumption

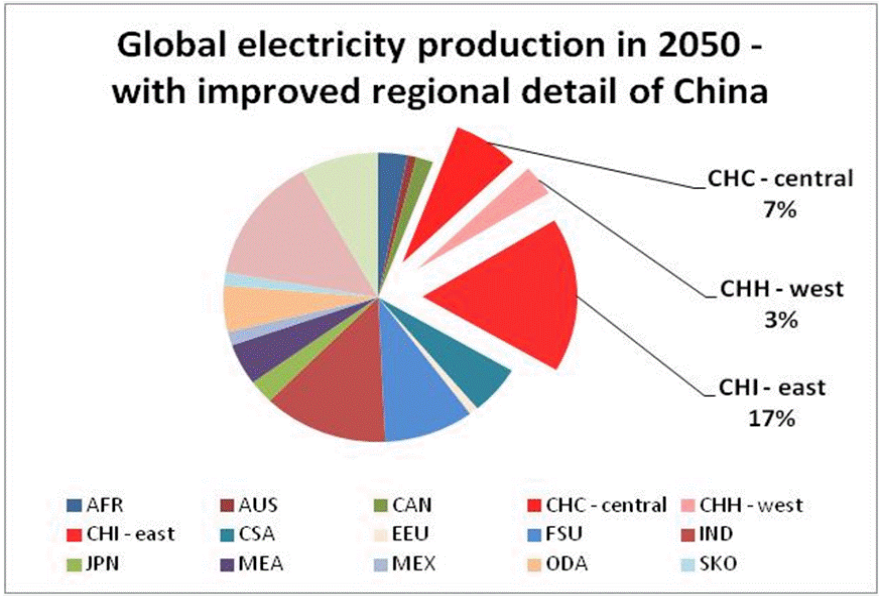
2005 Fuel mix	China National	East China	Central China	West China
Primary energy supply				
Final fuel consumption				

Coal, Coke and other coal products | Oil and petroleum products | Natural Gas and NGL | Electricity | Biomass

Modelling East, West and Central China in a global context (I)

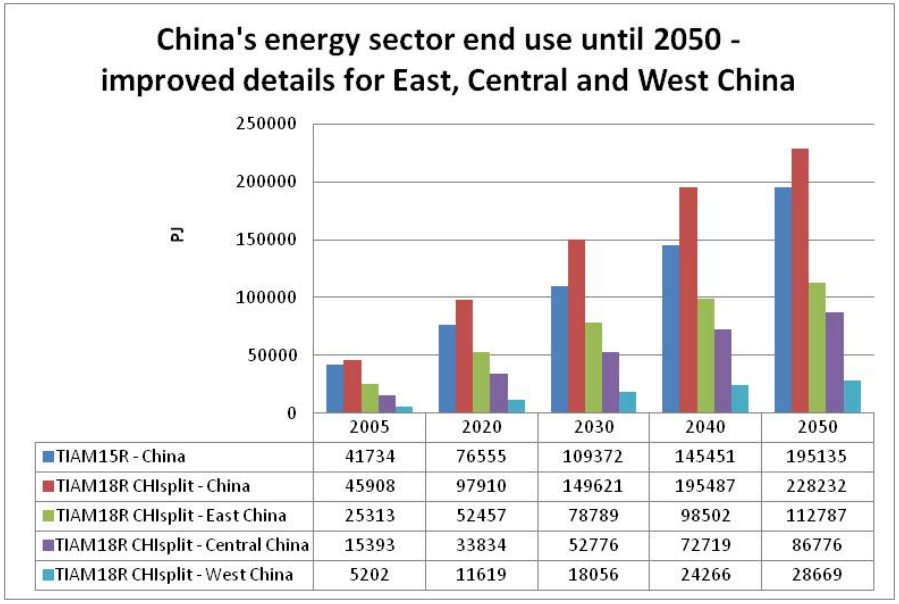
Improved modelling of China's power sector – Reference scenario test



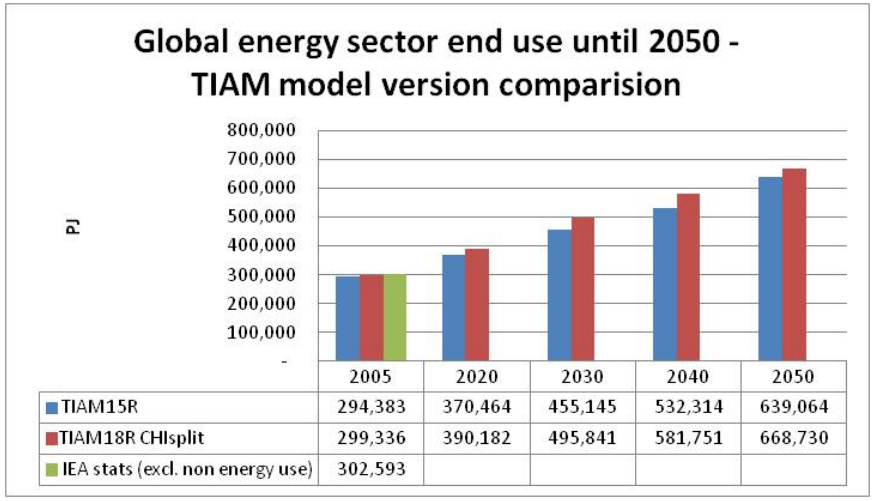


Modelling East, West and Central China in a global context (II)

Energy end use pathways until 2050 for China – Reference scenario test



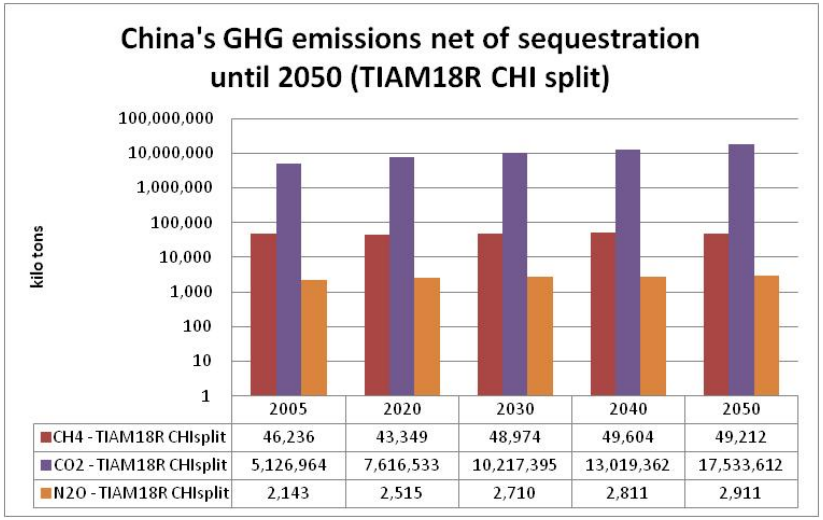
	2005	2020	2030	2040	2050
TIAM15R - China	41734	76555	109372	145451	195135
TIAM18R CHIsplit - China	45908	97910	149621	195487	228232
TIAM18R CHIsplit - East China	25313	52457	78789	98502	112787
TIAM18R CHIsplit - Central China	15393	33834	52776	72719	86776
TIAM18R CHIsplit - West China	5202	11619	18056	24266	28669



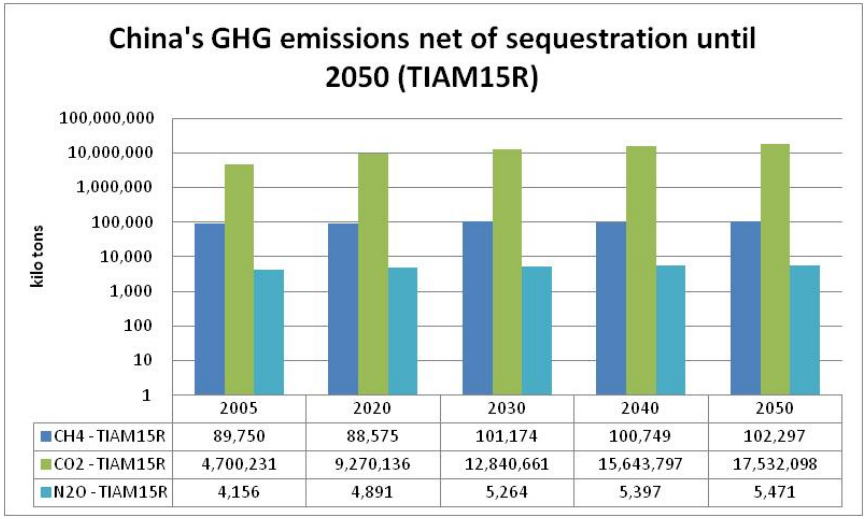
	2005	2020	2030	2040	2050
TIAM15R	294,383	370,464	455,145	532,314	639,064
TIAM18R CHIsplit	299,336	390,182	495,841	581,751	668,730
IEA stats (excl. non energy use)	302,593				

Modelling East, West and Central China in a global context (III)

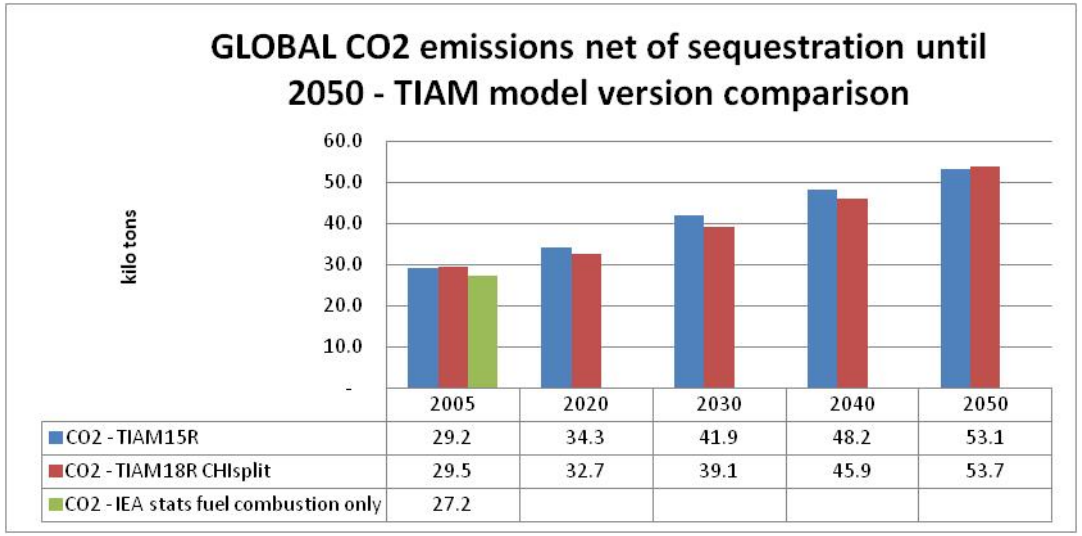
Future emission pathways until 2050 for China – Reference scenario test



	2005	2020	2030	2040	2050
CH4 - TIAM18R CHIsplit	46,236	43,349	48,974	49,604	49,212
CO2 - TIAM18R CHIsplit	5,126,964	7,616,533	10,217,395	13,019,362	17,533,612
N2O - TIAM18R CHIsplit	2,143	2,515	2,710	2,811	2,911



	2005	2020	2030	2040	2050
CH4 - TIAM15R	89,750	88,575	101,174	100,749	102,297
CO2 - TIAM15R	4,700,231	9,270,136	12,840,661	15,643,797	17,532,098
N2O - TIAM15R	4,156	4,891	5,264	5,397	5,471



	2005	2020	2030	2040	2050
CO2 - TIAM15R	29.2	34.3	41.9	48.2	53.1
CO2 - TIAM18R CHIsplit	29.5	32.7	39.1	45.9	53.7
CO2 - IEA stats fuel combustion only	27.2				

Section IV:

Next steps and discussion

Next steps and discussion…

- … to further improve the representation of China's regional energy system in TIAM and detailed documentation of the TIAM reference scenario assumptions
- … to update energy service demand drivers for East, Central and West China in TIAM
- … to focus more in depth on power and transport sector policiy analysis for East, Central and West China and implement this in TIAM
- … to plan my 2014 China research stay: 3 months around April – July 2014
- … to brainstorm about joint publications …
- … … …

Thank You!谢谢! Danke! Merci bcp!

For more information:

Email me: peym@dtu.dk

Follow my China energy blog: http://www.peggymischke.com/china-blog.html

Connect via LinkedIn: Peggy Mischke (佩吉• 密歇克), International Energy Specialist, Copenhagen Area, Denmark

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